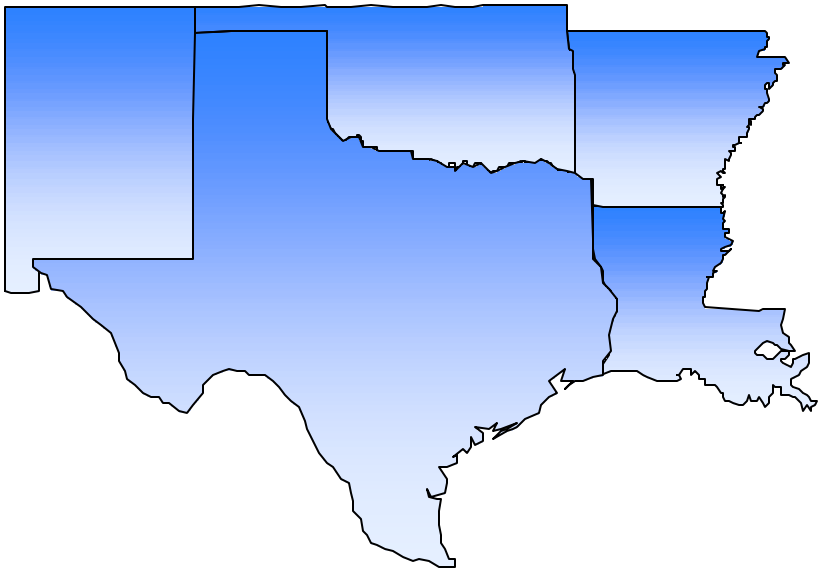
U.S. ENVIRONMENTAL PROTECTION AGENCY REGION 6

MITIGATION CIRCUIT RIDER PROGRAM

In Coordination with the U.S. Army Corps of Engineers



EPA United States Environmental Protection Agency

US Army Corps of Engineers

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EXECUTIVE SUMMARY

The U.S. Environmental Protection Agency Region 6 Mitigation Circuit Rider Program was developed to assess the effectiveness of compensatory wetland mitigation sites associated with permits issued under Section 404 of the Clean Water Act. Developed in 1997, this program was designed to give agency decision makers an indication of the efficacy of 404 permit mitigation conditions and to determine whether or not a more in-depth study was needed.

The purpose of the study was to make a preliminary assessment of the viability of compensatory mitigation methods that have been recommended by federal regulatory agencies in Region 6. The selection and assessment of sites for this study did not utilize statistical sampling designs, such as stratified random sampling, or detailed wetland functional assessment techniques, such as HGM.

This Mitigation Circuit Rider report presents the results of 100 selected individual wetland mitigation site reviews on assessing the effectiveness of mitigation efforts in EPA Region 6. The study investigated the effectiveness of wetland mitigation in (1) restoring, enhancing, creating, and preserving wetland functions and (2) adherence to permit mitigation conditions in eight U.S. Army Corps of Engineers Districts (Corps). A field review form was developed to assess wetland development success including parameters such as vegetation, wildlife, hydrology, and water quality, as well as mitigation special conditions for each site. Data gathered from each site was stored in a Microsoft Access 97 database.

A total of 100 mitigation sites were identified for site visits in New Mexico, Oklahoma, Texas, Arkansas, and Louisiana. Of these 100 sites, 89 are formally represented in this report. The remainder were excluded for a variety of reasons. In summary, the following results support a correlation between wetland development success and adherence to permit mitigation conditions:

- 56 sites were adhering to permit mitigation conditions of which 46 were developing successfully and 10 exhibited moderate development success.

- 23 sites were partially adhering to permit mitigation conditions of which one was developing fully, 19 exhibited moderate development success, and three were developing poorly.

- 10 sites were not adhering to permit mitigation conditions of which nine were developing poorly, and one was developing successfully.

Further detailed study is warranted. Similar efforts to assess the replacement of wetland functions through compensatory mitigation should provide for overall improvements in the quality of compensatory mitigation projects.

INTRODUCTION

In 1997, the Mitigation Circuit Rider Program was developed by the U.S. Environmental Protection Agency (EPA) Region 6 and the U.S. Army Corps of Engineers Southwestern, Mississippi Valley, and South Pacific Divisions, as a way to assess the effectiveness of wetland mitigation associated with Section 404 permits and to mutually strengthen the agencies' wetland programs. Pursuant to an agreement reached by the two agencies, a U. S. Department of Agriculture (USDA) Forest Service liaison was assigned to tour Region 6 and determine the success of restoration, creation, enhancement, and preservation mitigation efforts. An interagency task force was formed. The eight Corps District Offices and six Fish and Wildlife Service (FWS) Ecological Services Field Offices in Region 6 were solicited for candidate mitigation sites. More than 125 permits were initially recommended for consideration. 92 out of a planned total of 100 compensatory mitigation sites were visited in eight Corps Districts in New Mexico, Oklahoma, Texas, Arkansas, and Louisiana.

The Mitigation Circuit Rider program was intended only to assess the effectiveness of compensatory wetland mitigation sites associated with Section 404 permits. The program was not intended to assess Section 404 permit compliance or assess wetland functions as comprehensively as the Hydrogeomorphic Approach (HGM), for example. The program did not assess whether monitoring and maintenance requirements were effective.

Compensatory wetland mitigation typically involves activities such as restoration, enhancement, creation, and under exceptional circumstances, preservation of wetlands, wetland buffers, and natural habitats. These activities are carried out to replace or compensate for the loss of wetlands, natural habitat area or functional capacity resulting from projects authorized under Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act of 1899. Compensatory mitigation usually occurs in advance of or concurrent with the impacts to be mitigated, but may occur after such impacts in special circumstances.

METHODOLOGY

A total of 100 compensatory mitigation sites were selected for evaluation to determine the success of mitigation efforts. A field review form was developed to document permit file information and mitigation special conditions for hydrology and revegetation. A database was developed to store the information obtained from each site visit. The study procedures were reviewed and approved by the Division Commanders of each of the three Corps Divisions and the EPA Regional Administrator.

Site Selection/Sampling Design

The selection of sites for this study did not utilize statistically significant sampling designs, such as stratified random sampling. Rather, the intent of this study was to simply look at a sample of sites that included each of the eight Corps Districts in Region 6. Although there were guidelines for site selection, the process differed slightly from district to district. The individual Corps Districts and other resource partners identified specific sites to include in the study. For

some Districts, "problem sites" were identified, or sites where the status of the mitigation was unknown. Other Districts chose successful mitigation sites. In still others, files were selected without consideration of the type of action or condition at the mitigation site. Occasionally, site selection was made due to site location logistics. The Corps and EPA agreed on the final list of projects based on the following criteria:

- The permitted activity had been completed;
- Wetlands were impacted and compensatory mitigation was required;
- The project needed to be an in-kind replacement (replacing the original pre-permit wetland with an identical wetland type);
- The time line for development, implementation, and monitoring of compensatory mitigation and for meeting performance standards had expired;
- The mitigation was not accomplished through participation in a mitigation bank.

EPA then retrieved all pertinent site records from the appropriate Corps District offices.

Site Evaluation

A field protocol entitled, *A Clean Water Act Section 404 Permit Compensatory Mitigation Effectiveness Evaluation Pilot Program Review Procedures*, was developed and finalized in 1998. The elements of the protocol were reviewed by Dr. Bill Streever, Corps Waterways Experiment Station, in Vicksburg, Mississippi, and agreed to by the EPA Region 6 and the Corps. These criteria are reflected in the sample field review form (Figure 1).

To analyze the data, a two-part ranking criterion was developed which addressed wetland development success and adherence to permit mitigation conditions. The wetland development success criterion contained elements such as vegetative success and species composition, wildlife habitat, site selection, hydrology, and water quality functions. Adherence to permit mitigation conditions included information on construction techniques such as slope, surface water acreage, hydric conditions, invasive plant control, and monitoring reports. All of the monitoring reports in the selected project files were reviewed.

Additional items investigated included: number of wetland acres constructed or restored; whether the mitigation was conducted on or off-site; gross acres of the mitigation site; density of wetland vegetation at the mitigation site after implementation; and whether the mitigation project had one or several wetland types.

Figure 1

WETLANDS COMPENSATORY MITIGATION
FIELD REVIEW FORM

Date: *Arrival time:* *EPA Reviewer:*
Departure time: *EPA File No.:*

Corps District: *Corps Project Mgr.:*

Corps Permit No.: *Date issued:*

Applicant:
County/Parish: *State:*

Latitude: *Longitude:* *Watershed:*

Location (distance and direction to nearest highway, city, waterbody):

Project impacts on wetlands (types [Cowardin, et al., classification] /acreage):

Mitigation specifications included? *Date begun:*
Date finished (or % completed):

Schedule specified? *If so, was work started on time?* *Finished on time?*

Were monitoring reports required? *If yes, number submitted:*

Dates:

*Acreage of each type of work**	*Wetland type(s) mitigated (Cowardin, et al.)*
Enhancement	
Restoration	
Creation	
Preservation	

** Defined in Federal Guidance for the Establishment, Use, and Operating of Mitigation Banks, Federal Register, Vol. 60, No. 228, November 28, 1995 (58605-58614)*

Soil Series, Type(s) [from NRCS soil survey]:

Date of survey:

Figure 1, cont.

Mitigation Special Conditions

1) Briefly describe mitigation work required by permit. [If excavation was required, give slopes, depths, etc.]:

2) Was location specified in the permit utilized? If not, why?

3) Hydrologic restoration [what was required, what was implemented?]:

4*) Performance Standards (success criteria) required by the permit (note if each was met):*

5) Other special mitigation conditions, as required by the permit:

6) Species required by the permit to be re-vegetated:

Observations

1) Revegetation Results: See Table on next page.

Dominant vegetative species found:

Figure 1, cont.

Vegetation type	*Planting technique (seedling, volunteer, seed, etc.)*	*Observed density/ spacing*	*Required density/ spacing*	*Observed survival rate or % coverage*	*Required survival rate or % coverage*	*Required monitoring period*
Trees:						
Shrubs:						
Herbs:						

Figure 1, cont.

2) Fish and wildlife observed during the visit (species and approximate numbers):

Neotropical migrant birds:

Waterfowl:

Wading birds:

Raptors:

Invertebrates:

Amphibians:

Reptiles:

Freshwater fish:

Saltwater fish:

Small mammals:

Large mammals:

3*) Hydrology*

Describe any problems observed, such as erosion from wave action or high flows :

Include open water [measurement estimate]

4) Photographs taken and orientation (also, draw map or mark on plans position and direction of each shot):

Figure 1, cont.

Conclusions and Recommendations

1) In light of the above information, do the wetlands appear to be developing as intended?

Does it appear that the wetlands will mature into fully functioning wetlands?

a) Vegetation

Has vegetation reached maturity? *If not, estimate when it might occur:*

What is the likelihood of vegetation survival?

b) Water quality

What water quality functions is the site performing?

Is there an adequate buffer zone between the wetlands and the uplands?

c) Hydrology

Is the source of hydrology dependable?

2) What, if any, actions are recommended to improve or enhance future uses of this/these types of mitigation? (Address factors such as prevention of or reduction in excessive mortality, improvement in hydrology, site suitability, etc.

3) Does the project's compensatory mitigation appear to be in compliance with the permit? If not, describe what appears to be in non-compliance:

Vegetation: Vegetative cover was estimated using best professional judgment, tape measurement, and photo documentation. Tree, shrub, grass, and forb species were identified, as well as the relative cover of hydrophytic vegetation. Visual estimates were used to measure absolute and relative vegetative cover at most of the sites. Planted versus volunteer species were also noted on the field review form.

Wildlife: Wildlife was assessed through both direct observations of species and indirect signs such as tracks, scat, bird songs, and interviews with casual observers in the project vicinity.

Hydrology: Field indicators of hydrology were noted at each site. Some were divided into indicators of inundation and sources of water. Indicators of inundation and/or saturation during the growing season, depth of inundation and surface water area, and sources of water such as overbank flooding, precipitation, groundwater seepages, perched water tables, were also noted.

Water Quality: Ambient water quality for each site was not assessed since it was outside the scope of this study. Obvious nonpoint sources at mitigation sites, such as eroding banks or berms, were noted on the field review form.

Site Maintenance: Evidence of anthropogenic and natural impacts were assessed for each of the mitigation sites, both through the review of site maintenance reports, and on-site observation. Assessing uncontrolled human disturbance included evidence of all terrain vehicle (ATV) usage, trash, and cattle. Natural impacts assessed included evidence of hydrologic extremes such as drought, soil piping, erosion, water run off pollutants, and wildlife mortality.

Wetland Development Success Criteria

Ranking criteria were developed by EPA Region 6 to measure wetland development success by using best professional judgement to assess the biological, physical, and chemical features for each site. It was determined that this would provide an appropriate means to analyze the data collected. Based upon the data gathered during each site evaluation, mitigation sites were categorized according to their relative wetland development success.

Wetlands were determined to be *Fully Successful* when all wetland functions intended for the site appeared to be present and fully functional. Wildlife habitat appeared to be of good quality. Good coverage and diversity of desirable species were present on site. The vegetation appeared healthy and stable. The soil was stable and not eroding. The hydrology appeared to function as designed. The wetland appeared to have the opportunity and ability to improve water quality. The wetland appeared to be capable of some flood control function.

Wetlands were determined to be *Moderately Successful* when associated wetland functions appeared to some extent, but some functions were missing or not functioning as intended, or at a low level. Wildlife habitat appeared to be of medium quality. The site exhibited moderate or marginal coverage and diversity of desirable species. Vegetation mortality, disease, or stress ranged from moderate to significant. The soil on

the site was basically stable, although some erosion might have been evident. The hydrology was such that the site may be called a jurisdictional wetland. The wetland had at least some opportunity and potential ability to improve water quality. The wetland had at least some capability of functioning as flood control.

Wetlands were determined to be *Poorly Successful* when they did not appear to be functioning as intended or appeared to be functioning at a very low level. At these sites, the wildlife habitat appeared to be of poor quality. Poor coverage or low diversity of desirable species was exhibited. The vegetation appeared unhealthy or stressed, with a high incidence of mortality. The soil appeared poor or unstable, with erosion evident on site. In the poorly successful sites, the hydrology did not function as designed. The wetlands seemed to have little opportunity or potential ability to improve water quality. The wetlands appeared incapable of functioning as flood control.

Permit Mitigation Adherence Criteria

A determination was made by the EPA as to whether or not each project adhered to all major permit conditions for compensatory mitigation. Each site received a "yes", "partial", or "no" rating. Projects receiving a "yes" rating adhered to all major permit conditions for compensatory mitigation including meeting specifications and timing deadlines for both physical characteristics and the vegetation planted on the mitigation site. Projects receiving a "partial" rating adhered to at least some of the major permit conditions. In these cases, some of the specifications and timing for the physical elements of the site or for the vegetation may not have been met. Those sites receiving a "no" rating were those projects that essentially were not compliant with most or all of the major permit conditions for compensatory mitigation. In these cases, the permittee adhered to few, if any, of the specifications listed in the permit.

Site Visits

A pilot with the Fort Worth District was begun in 1998, with subsequent visits to other Corps Districts. On-site evaluations were conducted between October 28, 1998 and January 26, 2000 to observe wetland development success for comparison to permit mitigation conditions.

Where possible, each site visit was conducted with the Corps Regulatory Program project manager or project consultant present to answer questions and to provide the EPA with additional information that may not have been discussed in the permit file or monitoring reports. The information gathered during the site visits was entered into a Microsoft Access 97 database. After the site visits were completed, copies of the database and field review forms were distributed to the Corps Districts for review and comment. Additional comments from the individual Districts were incorporated directly into the database.

Analysis of Findings

The sites visited were divided into four categories based on type of mitigation. Each mitigation type was then further subdivided into wetland habitat types. The following four wetland mitigation types were observed during this study.

Creation: The establishment of a wetland or other aquatic resource where one did not formerly exist.

Restoration: The re-establishment of wetland and/or other aquatic resource characteristics and function(s) at a site where they have ceased to exist, or exist in a substantially degraded state.

Preservation: The protection of ecologically important wetlands or other aquatic resources in perpetuity through the implementation of appropriate legal and physical mechanisms. Preservation may include protection of upland areas adjacent to wetlands as necessary to ensure protection and/or enhancement of the aquatic ecosystem.

Enhancement: Activities conducted in existing wetlands or other aquatic resources which increase one or more aquatic functions.

The following types of wetland habitat systems as described by Cowardin, et al. (1979) were observed during this study: Palustrine and Estuarine. Various types of wetland classes within each system were also noted.

1. The *Palustrine System* includes all nontidal wetlands dominated by trees, shrubs, persistent emergents, emergent mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean-derived salts is below 0.5%. It also includes wetlands lacking such vegetation, but with all of the following four characteristics: (1) area less than 8 ha (20 acres); (2) active wave-formed or bedrock shoreline features lacking; (3) water depth in the deepest part of basin less than 2 m at low water; and (4) salinity due to ocean-derived salts less than 0.5%. Wetland classes within the Palustrine System that were observed include:

a. *Palustrine Emergent Wetlands* (PEM) are characterized by erect, rooted, herbaceous hydrophytes, excluding mosses and lichens. This vegetation is present for most of the growing season in most years. Usually, these wetlands are dominated by perennial plants. All water regimes are included except subtidal and irregularly exposed regimes. Palustrine Emergent wetlands are known by many names, including marsh, meadow, prairie pothole, and slough. The hydrology of these areas is a function of rainfall, runoff, groundwater, episodic flooding, and human management.

b. *Palustrine Scrub-Shrub Wetlands* (PSS) include areas dominated by woody vegetation less than 6 m (20 feet) tall. The species include true shrubs, young trees, and trees or shrubs that are small or stunted because of environmental conditions. All water regimes except subtidal are included. Palustrine Scrub-Shrub wetlands may represent a successional stage leading to forested wetland, or they may be relatively stable communities.

c. *Palustrine Forested Wetlands* (PFO) are characterized by woody vegetation that is 6 m tall or taller. All water regimes are included except subtidal. Forested wetlands are most common in the eastern United States and in those sections of the West where moisture is relatively abundant, particularly along rivers and in

the mountains. They normally possess an overstory of trees, an understory of young trees or shrubs, and an herbaceous layer.

d. *Palustrine Open Water* (POW) is a mapping unit used on USFWS National Wetland Inventory maps. POW sites are those deepest areas in the Palustrine System (greater than 2 meters deep at low water) and therefore are not wetlands, by definition. However, this mapping classification was useful in quantifying some mitigation site acreages. They may or may not contain aquatic vegetation. The bottom substrate is generally unknown.

e. The *Riparian System* (Rp) is a mapping convention used in New Mexico. Riparian areas are plant communities contiguous to and affected by surface and subsurface hydrologic features of perennial or intermittent streams, lakes, and drainageways. Riparian areas have one or both of the following characteristics: 1) distinctly different vegetative species than adjacent areas and 2) species similar to adjacent areas but exhibiting more vigorous or robust growth. The USFWS has not formally adopted a standardized riparian definition or developed conventions to guide the mapping of riparian areas.

f. *Prairie Buffers* are a special designation for a buffer surrounding a wetland mitigation site. They are composed of native prairie grasses and forbs which functions to buffer the wetland mitigation area from adjacent land uses such as improved pasture, cropland, urban, and other non-native habitats.

2. The *Estuarine System* consists of deepwater tidal habitats and adjacent tidal wetlands that are usually semi-enclosed by land but have open, partly obstructed, or sporadic access to the open ocean, and in which ocean water is at least occasionally diluted by freshwater runoff from the land. Estuarine wetlands are tidally influenced, with a saline content of greater than 0.5 ppt. Wetland classes within the Estuarine System that were observed include:

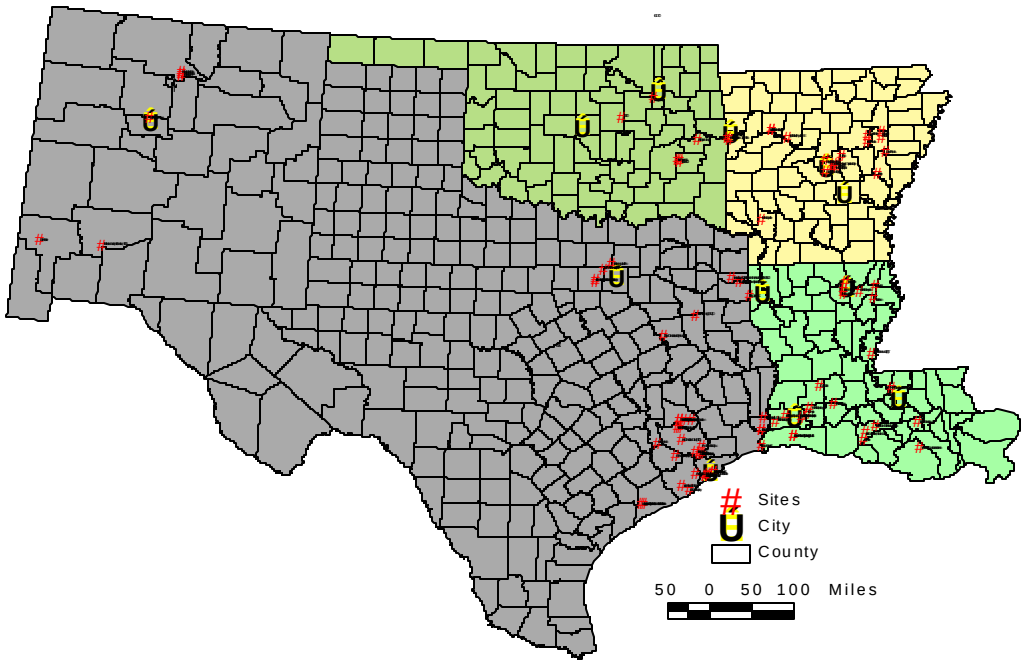
a. *Estuarine Intertidal Emergent Wetlands* (E2EM) are predominated by salt-marsh vegetation. Estuarine Emergent wetlands extend upstream or landward to the point where ocean-derived salts are less than 0.5 parts per thousand (during average annual flow). Like Palustrine Emergent wetlands, these wetlands are also characterized by erect, rooted, herbaceous hydrophytes. This vegetation is present most of the growing season in most years. These wetlands are usually dominated by perennial plants.

b. Estuarine Intertidal Scrub-Shrub Wetlands (E2SS) are seasonally and tidally flooded scrub-shrub wetlands. The class Scrub-Shrub wetland includes areas dominated by woody vegetation less than 6 m (20 feet) tall. The species include true shrubs, young trees, and trees or shrubs that are small or stunted because of environmental conditions.

RESULTS

One hundred permits were selected which had impacts to wetlands and required compensatory mitigation by Corps Districts in New Mexico, Oklahoma, Texas, Arkansas, and Louisiana. However, 89 sites were actually assessed for this study (Figure 2). Reasons for excluding the 11 sites included: mitigation site was too old to demonstrate current Corps mitigation policy, i.e. pre-1997 sites, mitigation was still under construction, or permitted activity was never begun, thus no mitigation was required.

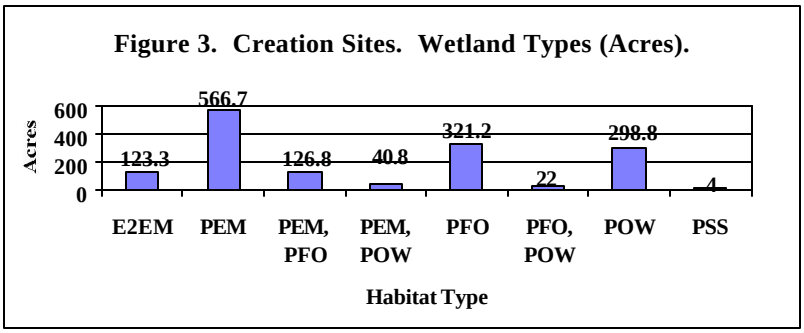
Figure 2. Distribution of Sites.



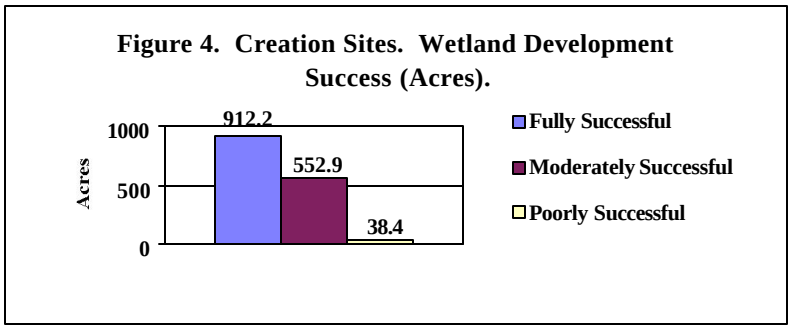
The sites visited can be divided into four categories based on type of wetland mitigation: creation, restoration, preservation, and enhancement. The following discusses the sites visited by mitigation type.

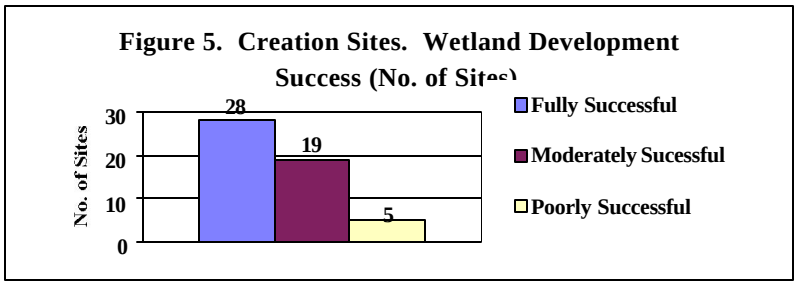
Creation Sites

Created wetland sites represented the majority of the sites visited during this study. A total of 52 sites, representing 1,504 acres of created wetlands, were assessed. Site size ranged from 0.2 acres to 500 acres. Multiple habitats were represented by these sites: Estuarine Intertidal Emergent (E2EM), Palustrine Emergent (PEM), Palustrine Forested (PFO), Palustrine Open Water (POW), and Palustrine Scrub-Shrub (PSS). Palustrine Emergent wetlands represented the bulk of the created wetland habitat types visited (38%, or 567 acres), with Palustrine Forested wetlands and Palustrine Open Water making up most of the remainder (Figure 3).



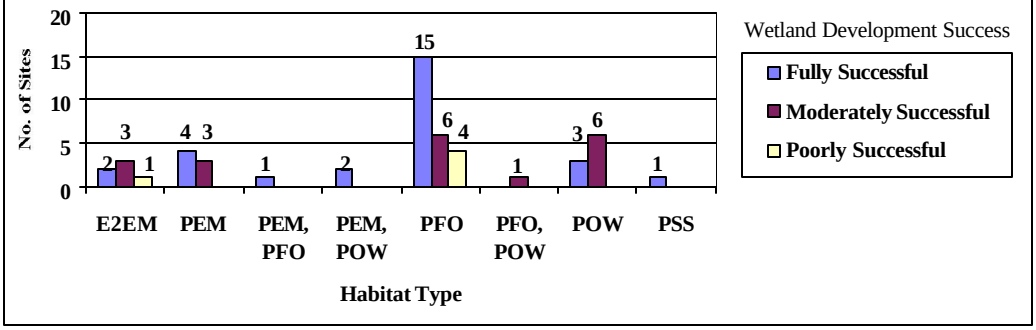
Of the wetlands created, 912 acres had fully successful wetland development, 553 acres were moderately successful, and 38 acres were considered to be not successful (Figure 4). Of the 52 wetland creation sites assessed, 28 were determined to be fully successful, 19 were moderately successful, and five were not successful (Figure 5).





If the created wetland mitigation sites are further categorized by wetland type, the mitigation success was mixed (Figure 6). Twice as many created Estuarine Intertidal Emergent (E2EM) sites were moderately to poorly successful as were fully successful. Four of the seven Palustrine Emergent (PEM) wetland sites were fully successful. While 15 Palustrine Forested (PFO) wetlands were determined to be fully successful, 10 were either moderately successful or poorly successful. Twice as many created Palustrine Open Water (POW) sites were moderately successful as were fully successful.

Figure 6. Creation Sites. Comparison of Wetland Development Success to Habitat Type.



In Figure 7, wetland development success is compared to adherence with permit mitigation conditions. Of the 52 creation sites, 30 sites appeared to fully adhere to permit mitigation conditions. Of these 30, 26 were deemed fully successful by the investigator. Of the 17 sites that partially adhered to the permit mitigation conditions, 15 were moderately successful. Five sites did not adhere to permit mitigation conditions. Four of these exhibited poorly developed wetlands.

Figure 7. Creation Sites. Comparison of Wetland Development Success to Permit Mitigation Adherence.

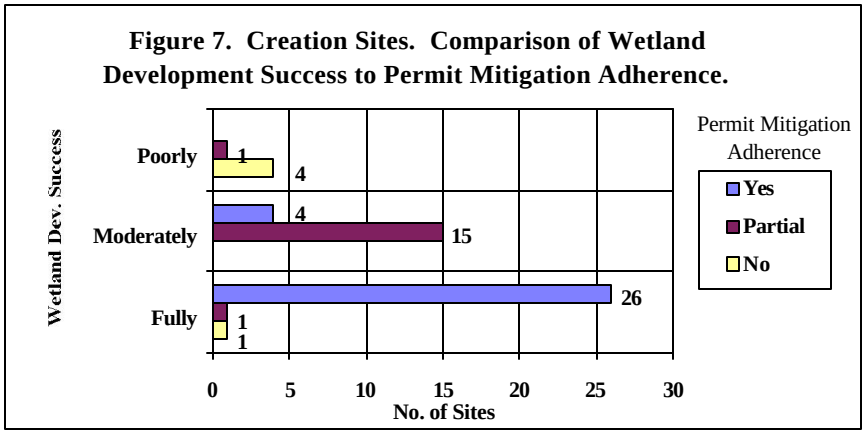
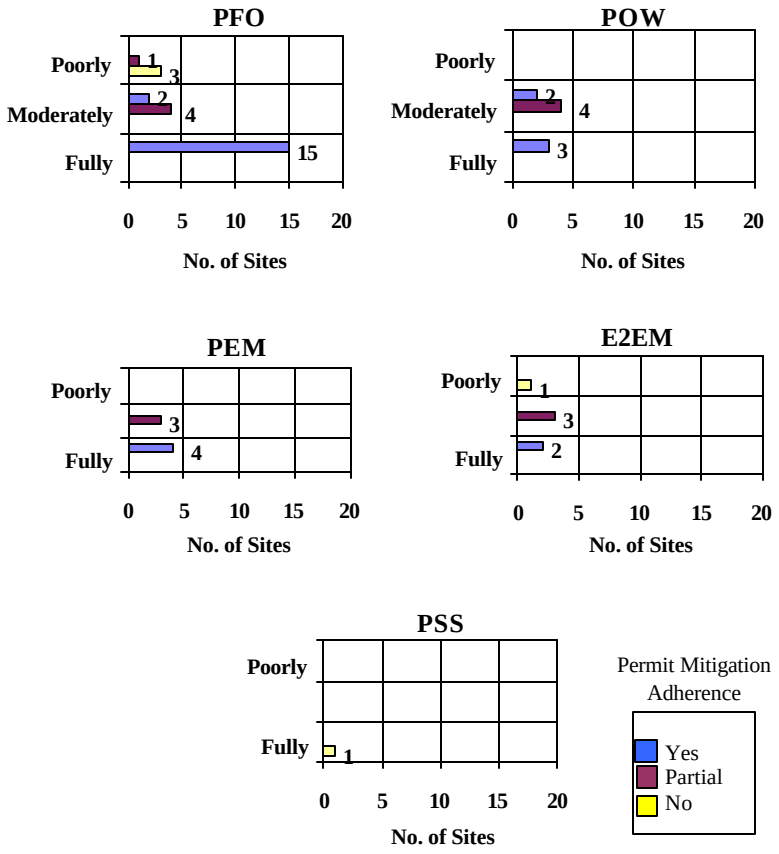


Figure 7, however, includes several creation sites that contained more than one wetland type. This study did not determine mitigation success or adherence with permit mitigation conditions on each wetland type within the same permit, but instead, generally made a wetland development success and permit mitigation adherence determination on the dominant wetland type present at each site.

When the mixed wetland type creation sites are excluded, as in Figure 8, there remains a strong correlation between permit mitigation adherence and wetland development success. Eight of the 10 Palustrine Forested wetland sites that were not fully successful exhibited partial or no adherence to the permit mitigation conditions. Of the Palustrine Open Water mitigation sites, all of the fully successful sites exhibited full adherence to permit mitigation conditions. Of the six that were moderately successful, four partially adhered to permit mitigation conditions. Of the Palustrine Emergent and Estuarine Intertidal Emergent wetland mitigation sites, all that adhered to permit mitigation conditions were fully successful, while those that partially or did not adhere to permit mitigation conditions were

moderately or poorly successful, respectively. Although the one Palustrine Scrub-Shrub site evaluated did not adhere to permit mitigation conditions, it was determined to be fully successful. Natural regeneration appeared sufficient to re-establish the willow component of the scrub-shrub wetland and the wetland appeared to be fully functioning.

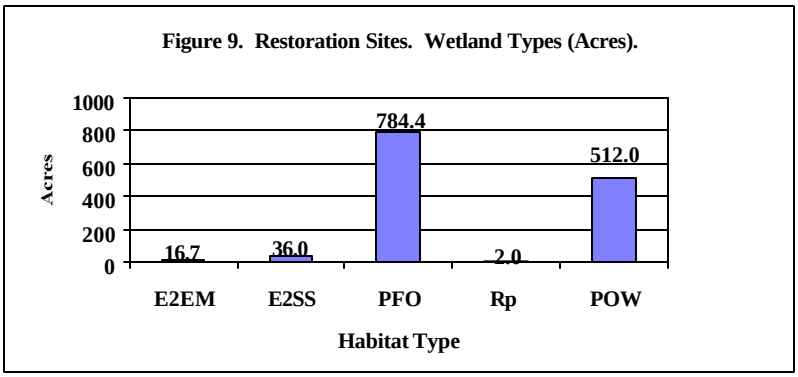
Figure 8. Creation Sites.
Comparison of Wetland Development Success
to Permit Mitigation Adherence for Specific Wetland Types.

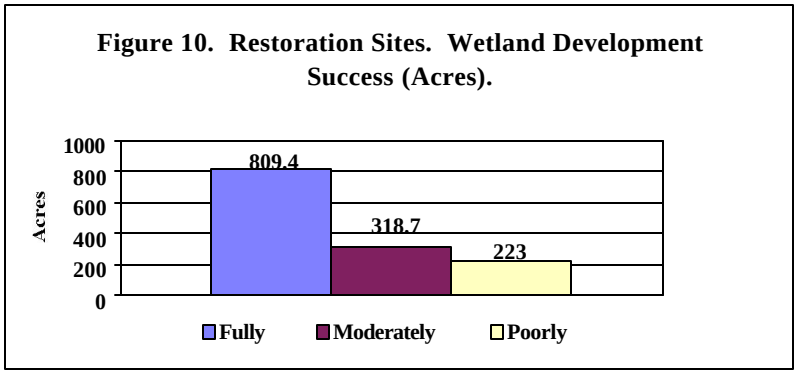


Restoration Sites

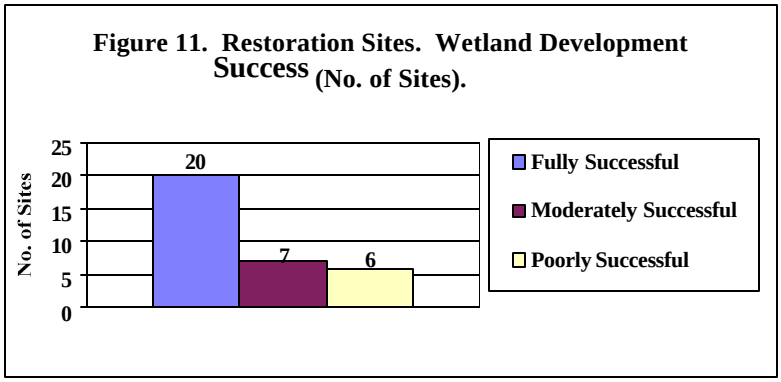
Following creation sites, restored wetland sites comprised the majority of the remaining mitigation sites visited. A total of 33 sites, representing 1,351 acres of restored wetlands, were assessed. Site size ranged from 0.7 acres to 500 acres. Multiple wetland types were represented by these sites, as well: Estuarine Intertidal Emergent (E2EM), Estuarine Intertidal Scrub-Shrub (E2SS), Palustrine Forested (PFO), Palustrine Open Water (POW), and Riparian wetlands.

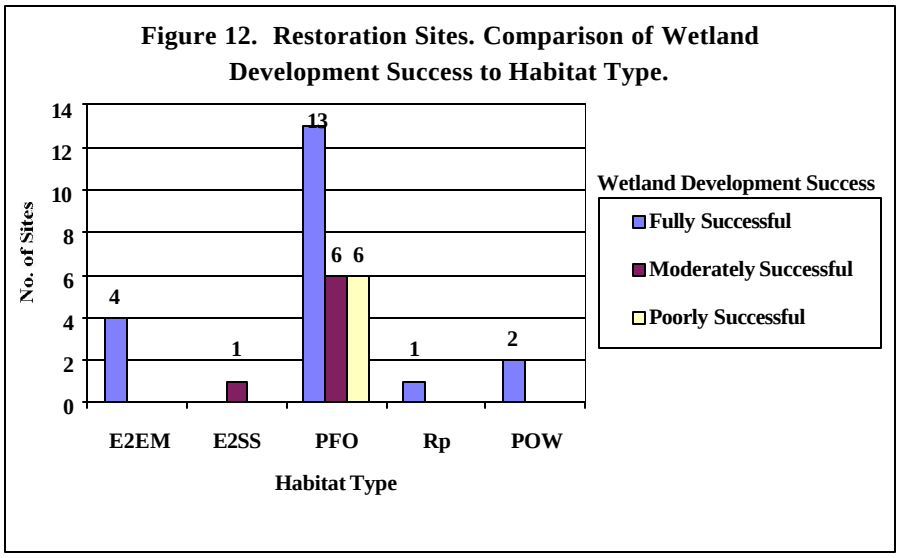
Palustrine Forested and Palustrine Open Water made up the majority of the acreage restored (Figure 9). Palustrine Forested wetlands represent 58%, or 784 acres. Palustrine Open Water represent 38%, or 512 acres. Of the restored wetlands, 809 acres had fully successful wetland development, 319 acres were determined to contain moderately successful wetlands, and 223 acres were considered to be poorly successful (Figure 10).



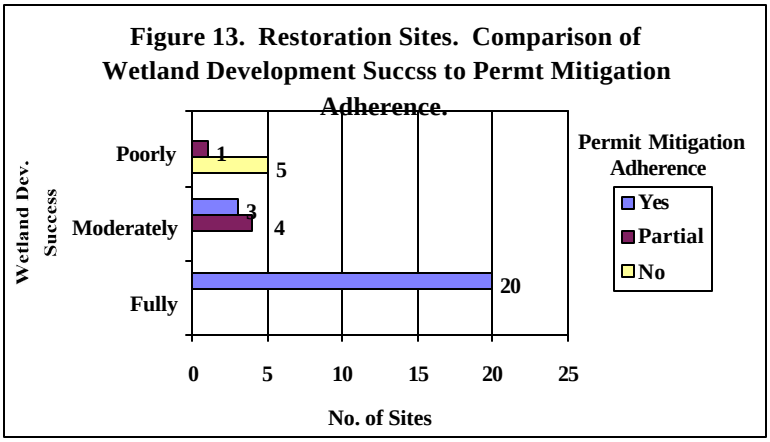


Of the 33 wetland restoration sites assessed, 20 were determined to be fully successful while seven were moderately successful and six were not successful (Figure 11). If the restored wetland mitigation sites are further categorized by wetland type (Figure 12), 12 of the 25 Palustrine Forested sites were either moderately or poorly successful. All Palustrine Open Water, Riparian and Estuarine Intertidal Emergent wetlands were successful. One restored Intertidal Emergent Scrub-Shrub wetland was moderately successful.



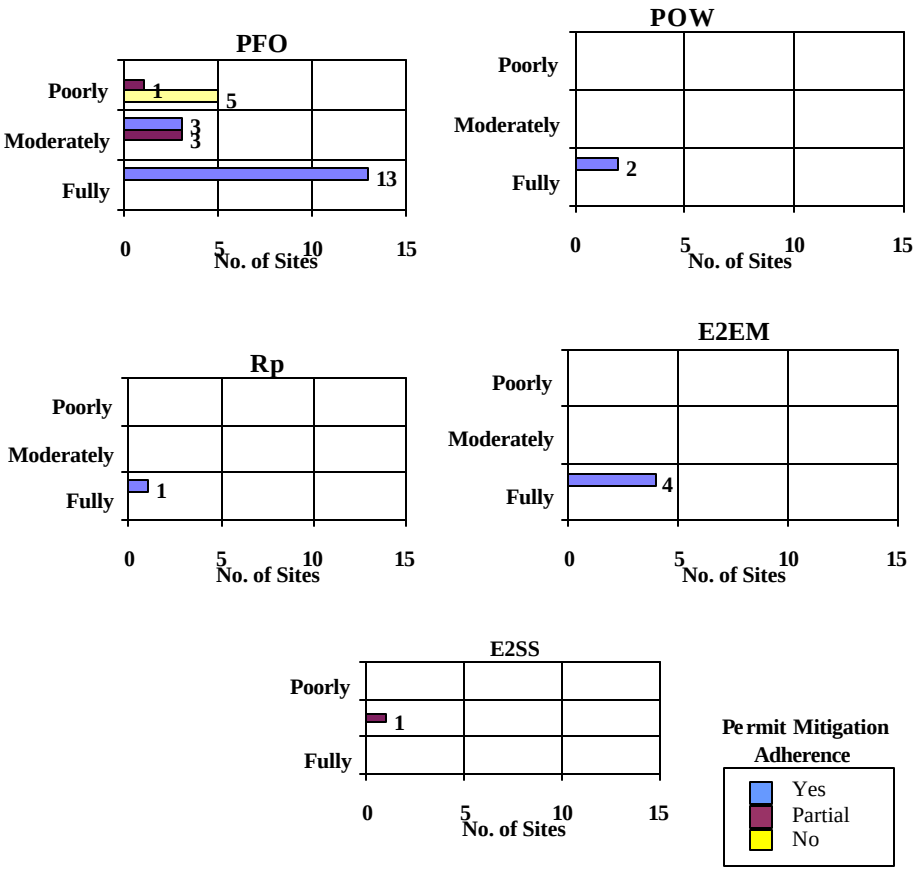


In Figure 13, restored wetland development success is compared to adherence with permit mitigation conditions. Of the 33 restoration mitigation sites, 23 fully adhered to the permit mitigation conditions. Of these 23, 20 were deemed fully successful by the investigator. Of the five sites that partially adhered to the permit mitigation conditions, four were moderately successful. Five sites did not adhere to permit mitigation conditions, all of which were deemed poorly successful.



Comparing the restoration sites' adherence to permit mitigation conditions to wetland development success, the three sites exhibited in Figure 13 that adhered to permit mitigation conditions but were deemed moderately successful were all Palustrine Forested (PFO) wetland restoration sites (Figure 14). Of the 16 PFO sites which fully adhered to permit mitigation conditions, 13 were fully successful. Of the four PFO sites that partially adhered to permit mitigation conditions, three were moderately successful, and one was poorly successful. Of the five PFO sites that did not adhere to permit mitigation conditions, all were poorly successful. The Palustrine Open Water, Riparian, and Estuarine Intertidal Emergent restoration types had a total of seven fully permit mitigation adherent sites, all of which were fully successful.

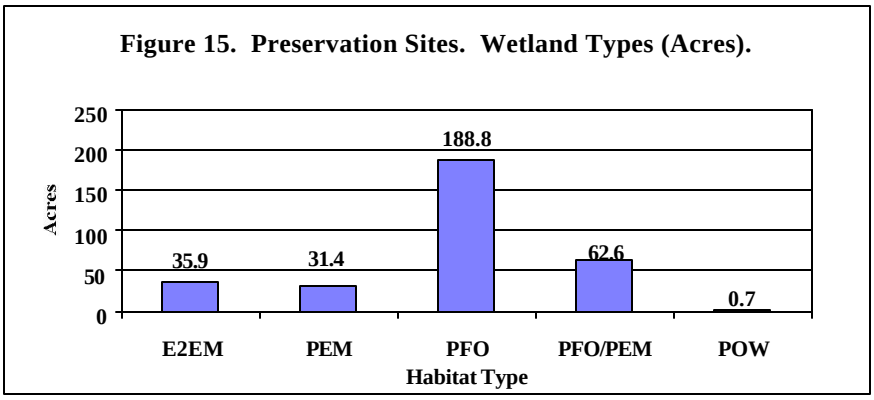
Figure 14. Restoration Sites.
Comparison of Wetland Development Success
to Permit Mitigation Adherence for Specific Wetland Types.



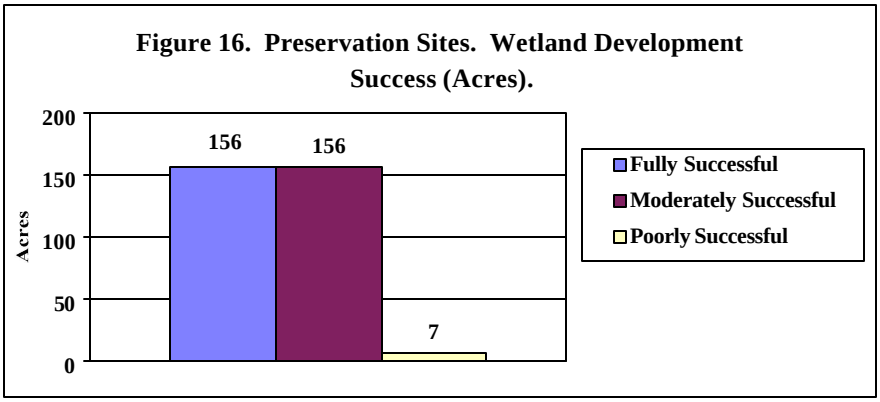
Preservation Sites

Although little to no alteration is required to preserve a site, mitigation sites where preservation was a component mitigation type were included in this study. A total of 13 sites, representing 319 acres of preserved wetlands, were assessed. Site size ranged from 0.1 acres to 96 acres. Types of preservation sites visited included Estuarine Emergent (E2EM), Palustrine Emergent (PEM), Palustrine Forested (PFO), and Palustrine Open Water (POW).

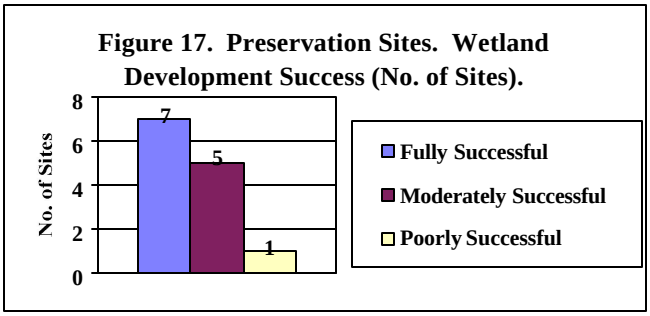
Over half of the acreage preserved was in Palustrine Forested wetlands (Figure 15). Palustrine Forested wetlands represented 59%, or 189 acres. In this study, the other two main wetland types preserved were Palustrine Emergent, followed by Estuarine Intertidal Emergent.

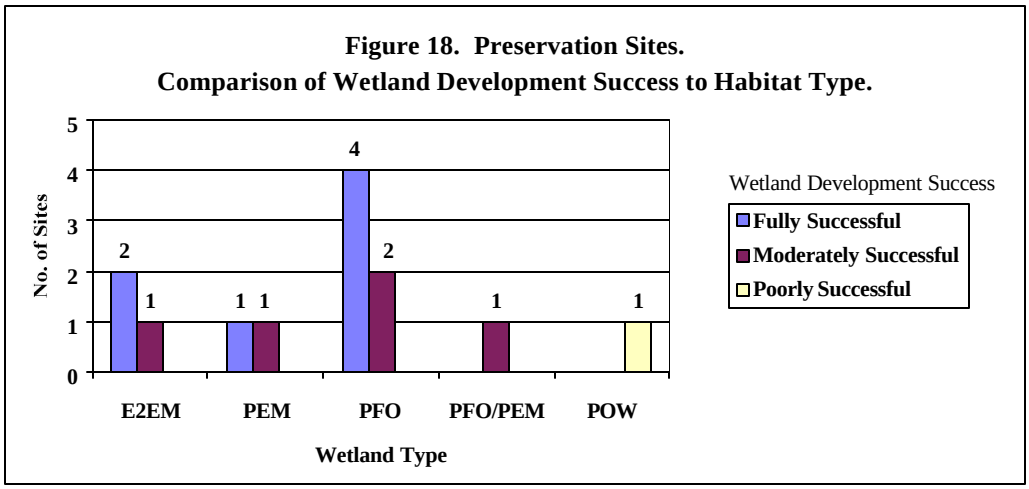


By definition, preserved wetlands should be fully successful unless there has been a change in one of the three wetland criteria: hydrology, hydric soils, or hydrophytic vegetation. Of the preserved wetlands, however, 156 acres had fully successful wetland development, 156 acres were moderately successful, and 0.7 acres were considered poorly successful (Figure 16). The lack of full success was due to such factors as: lack of control of woody invasive species (Chinese tallow tree), unrestricted cattle access with resulting damage, and bush-hogging or clearing of emergent vegetation around depressional wetlands.

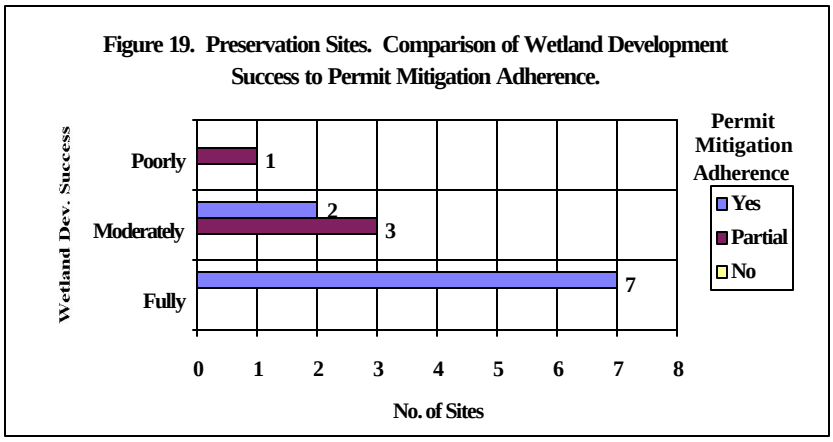


Of the 13 wetland preservation sites assessed, seven were determined to be fully successful while five were moderately successful, and one was poorly successful (Figure 17). If the preservation wetland mitigation sites are further categorized by wetland type, most of the successful sites were either Palustrine Forested wetlands or Estuarine Intertidal Emergent wetlands (Figure 18).



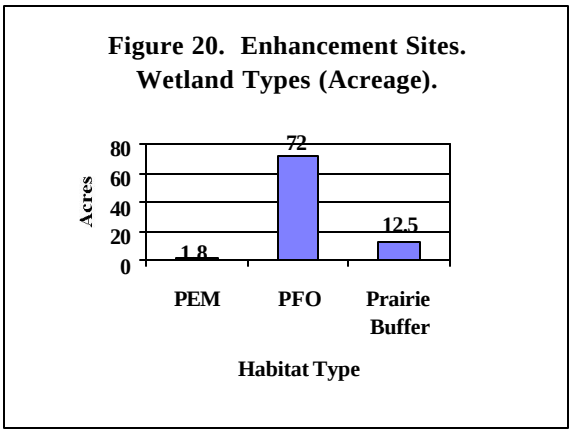


In Figure 19, preserved wetland development success is compared to adherence with permit mitigation conditions. Of the 13 preservation sites, nine fully adhered to permit mitigation conditions. Of these nine, seven were determined to be fully successful. Of the four sites that partially adhered to permit mitigation conditions, three were moderately successful. No preservation sites were visited that did not adhere to permit mitigation conditions.

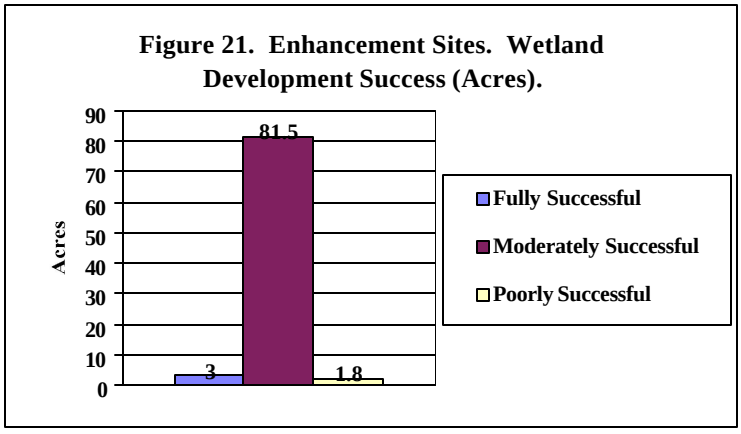


Enhancement Sites

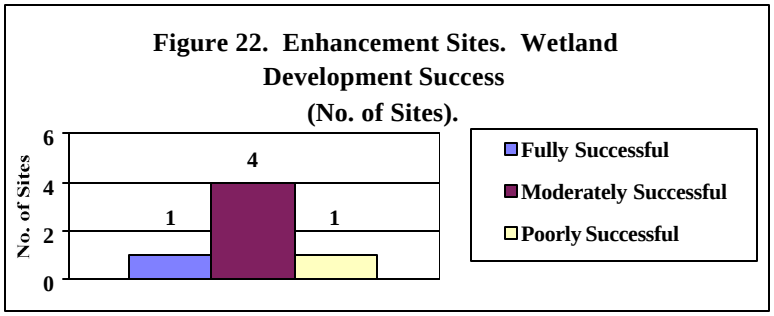
Six mitigation sites visited in this study, representing 86 acres of wetlands, exhibited wetland enhancement activity. Site size ranged from 1.8 acres to 39 acres. Palustrine Forested wetlands (PFO) comprised 83% of the acreage, while Prairie Buffer made up 14% of the total acreage (Figure 20).



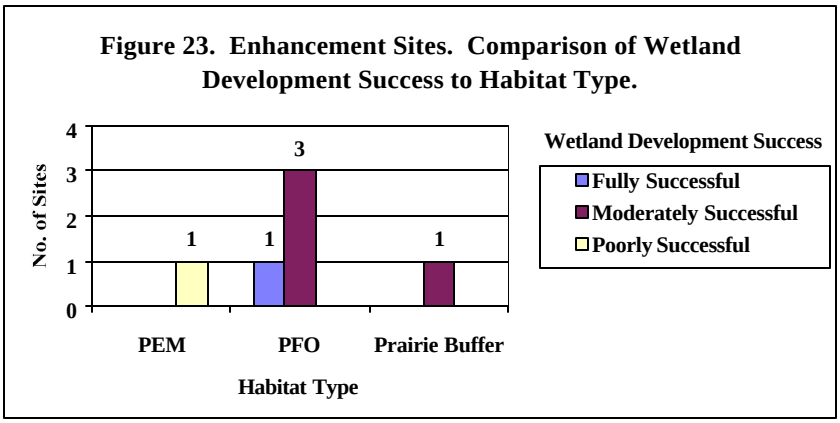
Too few enhancement sites may have been assessed during this study to draw any significant conclusions. Three acres had fully successful wetland development, 82 acres were moderately successful, and two acres were considered poorly successful (Figure 21).



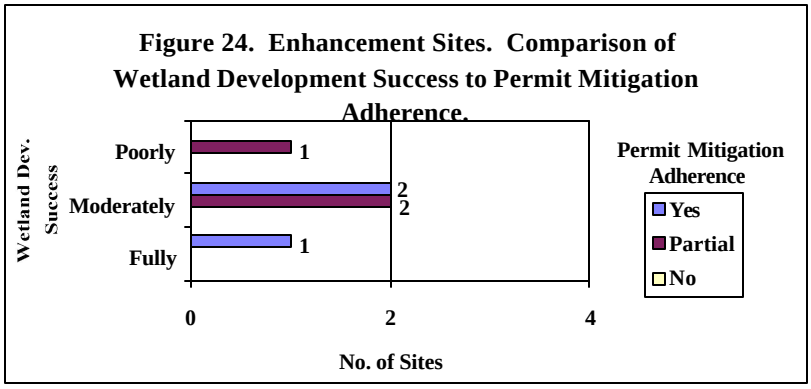
Of the six wetland enhancement sites assessed, one was determined to be fully successful, four were moderately successful, and one was poorly successful (Figure 22).



If the wetland enhancement mitigation sites are further categorized by wetland type (Figure 23), the one poorly successful site was classified as Palustrine Emergent wetland (PEM). On this site, poor construction design of an earthen berm which failed during flood events was the reason for the rating. The majority of sites in the fully to moderately successful category were Palustrine Forested wetlands.



In Figure 24, wetland development success is compared to adherence with permit mitigation conditions. All sites were found to be either fully or partially adherent to permit mitigation conditions. Of the six enhancement sites, three adhered to permit mitigation conditions. Of these three, one was rated as successful while the other two were moderately successful. Of the three mitigation sites that partially adhered to permit mitigation conditions, two were moderately successful and one was determined to be not successful. Reasons for less than fully successful wetland development at some enhancement sites included a lack of invasive species control (Chinese tallow tree), inadequate planting density, and inadequate enhancement structures such as the previously mentioned earthen berm. As a result of the site visit, the berm design is being altered.



DISCUSSION

Overall, this study found that there was a close correlation between wetland development success and adherence to permit mitigation conditions. 56 sites were adhering to permit mitigation conditions of which 46 were developing successfully and 10 exhibited moderate development success. 23 sites were partially adhering to permit mitigation conditions of which one was developing fully, 19 exhibited moderate development success, and three were developing poorly. 10 sites were not adhering to permit mitigation conditions of which nine were developing poorly, and one was developing successfully.

A commonly observed reason for assessed mitigation sites not ranking *Fully Successful* with regard to wetland development success was a lack of appropriate vegetation. At these sites, planting techniques were not adequate to insure sustainable vegetative density or percent cover. Plant survival may have also been compromised in several cases by the drought-like conditions experienced in many areas of EPA Region 6 during the study period. An abundance of less desirable exotic plant species and/or non-hydrophytic vegetation was also a determining factor in the wetland development success ranking.

Another commonly observed reason for a less than *Fully Successful* ranking included insufficient hydrology. This may have resulted from poor initial site selection or faulty water control structures. Additional reasons for assessed mitigation sites not ranking *Fully Successful* with regard to wetland development success included herbivory and excessive on-site erosion.

Monitoring of completed compensatory mitigation sites is perhaps one of the more direct approaches to insure the development of high quality projects capable of replacing the full suite of wetland functions. Resource considerations must be taken into account in the implementation of such a concerted effort. Follow-up monitoring of compensatory mitigation sites and compliance assistance would provide for addressing identified issues such as vegetative community success and improved hydrology in a timely manner.

Factors in Vegetative Success and Failure

From this study, it is not possible to determine the exact reasons for wetland mitigation success and failure at every site assessed. In general, mitigation sites which involve complex hydraulic engineering features and/or questionable water sources (i.e., pumped) are more costly to develop, operate and maintain, and have a higher risk of failure than sites designed to function with little or no human intervention. The former situations should only be considered where there are adequate assurances to ensure success. Long-term maintenance conditions may be necessary and appropriate in some cases (i.e., invasive exotic plant species control or reduced cattle grazing) to ensure vegetative success and viability. For the mitigation sites assessed, there was no documented quality control of planting operations. The following inferences are based on empirical observations from the field during this study, and on previous studies regarding vegetative planting survival rates by wetland type.

Palustrine Emergent Mitigation Sites

Many factors may have contributed to the low survival of plantings at some Palustrine Emergent mitigation sites. These factors include catastrophic meteorological events such as prolonged drought, insufficient planting techniques, competition from upland species, invasion of exotic species such as Chinese tallow, depredation by mammals, improper species selected for specific sites, and lack of vegetative colonization. A combination of these factors may indicate the need to alter the planting design, to perform selective maintenance, or of system failure.

Maintenance activity, largely through removal of undesirable vegetation on a frequent basis following construction, and less often as desirable species become established, is essential for achieving the desired ecological communities within a reasonable time frame.

Palustrine Scrub-Shrub Mitigation Sites

Only a few sites in this category were assessed. The elevation at one site precluded the natural flooding regime for establishment of frequently-flooded species such as willow.

Palustrine Forested Mitigation Sites

Research has demonstrated that variables such as depth of planting, seed source and variability, seedling stock quality, site conditions, quality control in acorn collection and handling, and adherence to guidelines on planting and direct seeding are important components of high survival rates. Rodent damage and weed competition are also possible contributors to poor seedling establishment. In forested wetlands, hydroperiod is the most important factor influencing productivity. However, submergence of newly established trees can be deleterious to individual tree species, depending on the season flooded, the depth of flooding, and the duration of the flood event. Survival of seedlings under flooded conditions is extremely variable, but increases when seedling species are adapted to the site, when seedlings are of good vigor, and when flooding duration is brief and waters are not stagnant. Without further careful monitoring and/or planting operations quality control, it is difficult to ascertain the exact causes of poor survival of trees at some Palustrine Forested mitigation sites.

Estuarine Emergent Mitigation Sites

Problems observed for these sites included wave-induced erosion. Generally these were isolated events. There was an incident at one site in which cattle had denuded the area of all vegetation.

Estuarine Scrub-Shrub Mitigation Sites

Only a few sites in this category were assessed. Shoreline erosion was again the primary reason for lack of success at sites visited.

RECOMMENDATIONS

The purpose of this study was to make a preliminary assessment of the viability of compensatory mitigation methods that have been recommended by federal regulatory agencies in Region 6. The selection and assessment of sites for this study did not utilize statistical sampling designs, such as stratified random sampling, or detailed wetland functional assessment techniques, such as HGM. Data analysis and conclusions may have also been affected by limitations of the database and resources available for the study.

This study did not utilize statistically significant sampling techniques in the selection of assessed mitigation sites. Future studies should utilize a stratified random sampling design. By dividing the area into non-overlapping homogeneous strata (i.e., by state, Corps district, or watershed) and selecting sites independently at random within strata, the data collected would better represent the area being assessed and would be more ecologically meaningful.

Wetland development was assessed in large part by empirical observations in the field, based on best professional judgment, and therefore relied heavily on vegetation, primarily as providing aquatic habitat, as an indicator of success. More detailed, structured wetland functional assessment techniques should be utilized in future studies. Recommended wetland assessment methodologies include Hydrogeomorphic Approach (HGM) functional profiles or assessment models. Future wetland functional assessments utilized should examine a full suite of wetland functions including habitat, floodwater retention, shoreline erosion control, and water quality improvement through attributes such as landscape position, hydrologic regime, hydric vegetation, and hydric soils.

In this study, some mitigation sites had more than one type of mitigation and/or more than one wetland type. In many of these cases, overall statements of adherence with permit mitigation conditions and wetland development success were made for the entire site. This methodology tended to skew some of the results when permit adherence and mitigation success were examined by individual mitigation or wetland type. For example, a site might contain 90 acres of Palustrine Forested wetland preservation and 10 acres of Palustrine Open Water creation. If the mitigation success of the preservation is excellent, but the mitigation success of the open water area is poor, the site would rate as fully successful since the preponderance of the site is fully successful. This methodology does not accurately reflect the success rate of the minority mitigation or wetland type. To be more accurate, future studies should endeavor to assess each individual mitigation and wetland type as a separate component of the entire site. Modifications should be made to the database to allow the data collector to rate both individual mitigation types, and wetland types within the same site.

The completed field review forms and subsequent data incorporated into the database was reviewed by the eight Corps Districts and comments were incorporated directly into the database. Most of these comments are reflected in this report. An individual follow-up review of each mitigation site by EPA staff following Corps comments was not feasible in this study due to limited available time and resources. Future studies should maximize partnering agency on-site participation and data collection in the assessment of each mitigation site.

Further detailed study is warranted. Similar efforts to assess the replacement of wetland functions through compensatory mitigation should provide for overall improvements in the quality of compensatory mitigation projects. With the appropriate recommended modifications to the study design, and partnering agency collaboration, resource agencies will move closer towards insuring no net loss of wetland functions.

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